Novel anastomotic method enables aortofemoral bypass for patients with porcelain aorta

Tadahiro Sasajima, MD, PhD, Masashi Inaba, MD, Nobuyoshi Azuma, MD, Nobuyuki Akasaka, MD, Hidenori Asada, MD, Hisashi Uchida, MD, Yumi Sasajima, MD, and **Kazutomo Goh, MD,** *Asahikawa, Japan*

Purpose: **Porcelain aorta is an indication for axillofemoral bypass. However, the procedure has definitive flaws. We present a new method for achievement of aortofemoral bypass.**
Methods: **The portion of the distal aorta for anastomosis is wrapped with a double polytetrafluoroethylene mesh and fixed to the adventitia with continuous sutures. The adventitia of the anastomotic site is cut over the mesh until the calcified surface is disclosed. Margins of the mesh and the peeled adventitia are fixed along the anastomotic margin with continuous sutures. After the aorta and distal arteries are occluded with balloon catheters, an opening on the bared calcification is made with an airdrill and enlarged with a laminectomy rongeur. The anastomosis is performed between a graft and the mesh-reinforced adventitia with continuous sutures. Over 6 years, this method has been applied to nine patients with porcelain aorta who are diabetic or undergoing dialysis. The indications were disabling claudication in three patients and limb salvage in six patients.**
Results: **No anastomotic complications or operative deaths were seen, and satisfactory mid-term results were obtained, with follow-up ranging from 3 to 62 months after surgery. One patient died of coronary heart disease 3 years after surgery, but the grafts retained a good function.**
Conclusion: **This method is safe and effective, and more liberal application of this method may help improve outcome and quality of life. (J Vasc Surg 2002;35:1016-9.)**

Aortofemoral bypass is the procedure of choice for aortoiliac occlusion. However, patient high-risk factors or certain local factors prevent use of this conventional procedure. Porcelain aorta, which is frequently found in patients who are diabetic or undergoing dialysis, is an absolute local factor, and in such cases, axillofemoral bypass has been preferred as an easier and less invasive alternative procedure. However, in comparison with aortofemoral bypass, axillofemoral bypass has the following definitive flaws: a lower patency rate,[1] a significant incidence rate of specific complications, such as proximal disruption[2] or thromboembolism,[3] and probably a higher graft infection rate and restrictions on physical activities, which decrease patient quality of life. Current aggressive approaches of percutaneous and surgical coronary revascularization have attained acceptable immediate-term outcomes for patients with ischemic heart disease who are diabetic or undergoing dialysis.[4,5]

This improvement in longevity and quality of life may be negated in such patients when axillofemoral bypass is performed because of porcelain aorta. In opposition to recent reports of the compatible long-term patency of axillofemoral bypass,[6,7] acknowledgement exists that the indication for aortofemoral bypass should be extended. With this background, current advances in vascular techniques may not justify axillofemoral bypass only because of a porcelain aorta. In this paper, we report a safe and reliable anastomosis method that enables aortofemoral bypass in patients with porcelainized aorta.

From the Department of Surgery, Asahikawa Medical University.
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Reprint requests: Tadahiro Sasajima, MD, Department of Surgery, Asahikawa Medical University, Midorigaokahigashi 2-1, Asahikawa 078-8510, Japan (e-mail: sasajit@asahikawa-med.ac.jp).

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MATERIALS AND METHODS

Patients. Between May 1995 and March 2001, 220 patients with chronic lower limb ischemia underwent bypass for aortoiliac occlusive disease. Of the 220, 12 patients had a diagnosis, as a result of encircling calcification seen on a preoperative routine computed tomographic (CT) scan, of porcelain aorta for which axillofemoral bypass was expected (Fig 1). Of these 12 patients, nine underwent the method of this report. This group included a long history of diabetes in seven patients, dialysis caused by diabetes in three patients, and dialysis caused by glomerulonephritis and polycystic kidney in one patient each. The remaining three patients underwent axillofemoral bypass because of high risk or lack of preoperative cardiac evaluation. The mean age of the nine patients was 66.3 ± 9.2 years (range, 48 to 74 years), and there was only one female patient. The indications for operation were longstanding disabling claudication in three patients and limb salvage in six patients. Before surgery, all of the patients underwent screening magnetic resonance angiography for carotid artery stenosis, dipyridamole-stress-thallium imaging for coronary artery disease, and subsequent coronary angiography if necessary. The procedures included eight aortofemoral(-femoral)-popliteal or crural bypasses and one unilateral femoral bypass. In the preoperative examination results, coronary artery disease was found in four patients, two of whom

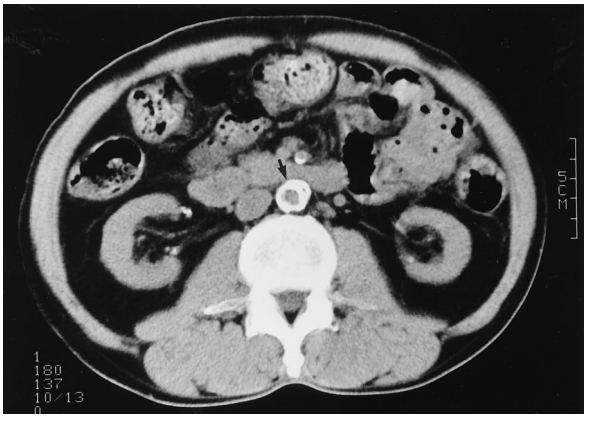

Fig 1. Porcelain aorta *(arrow)* in 48-year-old patient undergoing dialysis.

needed off-pump coronary artery bypass grafting followed by aortofemoropopliteal bypass or preoperative percutaneous coronary intervention.

All of the patients were followed up every 3 months for the first 2 years and every 6 months thereafter. The graft patency was easily comfirmed with palpation of the graft pulses and duplex scan and with magnetic resonance angiographic imaging in selected cases. Aneurysm formation at the proximal anastomosis was evaluated with routine postoperative CT scans or three-dimensional reconstruction from spiral CT data or both at 1 and 6 months and annually thereafter.

Operative technique. A lower paramedian incision was made, and the distal abdominal aorta was exposed through a retroperitoneal approach. Two vessel loops were applied to the expected anastomotic site of the aorta, and the adjacent lumbar arteries were ligated and dissected. After the distal aorta was dissected free from the vena cava and surrounding tissue, the anastomotic site was wrapped with a double polytetrafluoroethylene mesh (#0117841; C. R. Bard, Murray Hill, NJ). The longitudinal suture line of the wrapped mesh should be located at the left posterolateral aspect of the aorta and fixed to the adventitia with continuous 4-0 polypropylene sutures (Fig 2, *A*); the distal and proximal margins of the mesh were tacked to the adventitia of the aorta with 4-0 polypropylene as well. After intravenous heparin administration, the left iliac artery was ligated to prevent atheroembolism as a result of the aortic occlusion balloon catheter (12F-10; LeMaitre Vascular, Burlington, Mass), which then was inserted through an uncalcified spot proximal to the ligation. A 5F Fogarty thrombectomy balloon catheter or embolectomy-irrigation balloon catheter (DL-5F-IE-40; LeMaitre Vascular) also was inserted from the common femoral artery for occlusion of the right common iliac artery. When insertion of the aortic occlusion balloon from the left iliac artery seemed impossible because of organized thrombus, the right common femoral artery was used. On palpation of the aorta, when the porcelain aorta had crevices and was compressible, a cross-clamp with the Fogarty hydrogrip clamp was applied at the crevices parallel to the opposed calcification plates. After the occlusion balloons were adequately placed distal and proximal to the anastomotic site, the adventitia at the anastomotic site was cut over the mesh with a sharp-bladed knife until the calcified surface was disclosed. The adventitia was peeled from the calcified surface sufficiently to provide a sufficient suture margin for anastomosis. The peeled adventitia and the margin of the mesh were fixed along the anastomosis with continuous sutures of 4-0 polypropylene (Fig 2, *A*). After the occlusion balloons were inflated to an adequate size proximal and distal to the anastomotic site, an opening on the bared calcification at the anastomotic site was made with an airdrill with a diamond tip (Fig 2, *B*) and enlarged with a laminectomy rongeur to an adequate anastomotic caliber (Fig 2, *C*). Before use of the rongeur, it was important to check the balloons so as not to burst them. If the inflated balloons were visible through the anastomotic opening or if there was excessive bleeding from the aortotomy, the occlusion balloons were redeployed at an adequate position. Bleeding from the anastomotic opening during aortic balloon deflation during the redeployment was easily controllable with occlusion with a fingertip. The calcification at the anastomosis should be removed with about 5 mm greater than the fixed adventitial caliber. The anastomosis was performed between an 8 mm–diameter polyester graft and the mesh-reinforced adventitia with 4-0 polypropylene continuous sutures (Fig 2, *D*). Before deflation of the occlusion balloons, an application of fibrin glue to the anastomotic site was useful for control of oozing and for enhancing adhesion between the adventitia and the mesh. Anastomosis to a porcelain femoral artery was performed in the same manner.

RESULTS

All of the nine patients had porcelain calcification in the infrarenal abdominal aorta and most of the iliac and femoral arteries. Of the nine patients, a proximal aortic clamp was applicable at a crevice in a gentle manner in three patients, but the remaining six needed application of a balloon occlusion technique. Inferior vena cava was adherent to the porcelain aorta in two cases, but no serious bleeding occured during the dissection, nor did complications during anastomotic procedures, such as bursting of the occlusion balloon with excessive hemorrhage. Oozing through the mesh-adventitia complex occurred in one patient undergoing dialysis, but complete hemostasis was attained through a 10-minute manual compression. The mean clamp time for the proximal anastomosis was 30.6 ± 8.6 minutes. Amount of bleeding during aortic anastomosis was minimal in eight patients, but one patient for dialysis had blood loss of more than 300 mL because of inadequate balloon occlusions for the opening of lumbar arteries at the anastomotic site. With 17.4 months of mean follow-up period (range, 3 to 62), all of the grafts were patent and continued a good

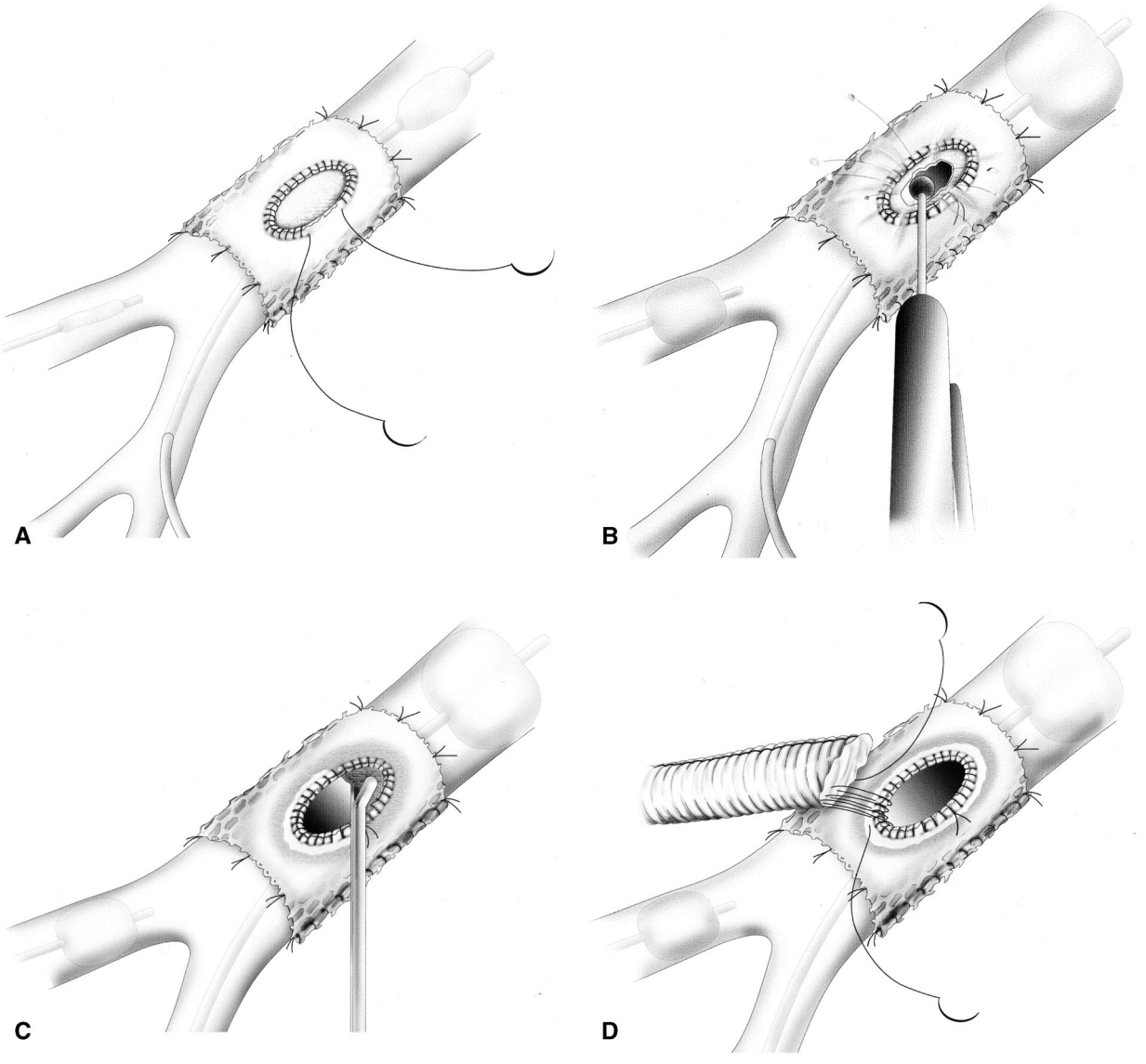

Fig 2. Anastomotic techniques. **A,** Mesh wrapping of anastomotic site. Longitudinal suture line should be located at posterolateral aspect of aorta. Mesh is fixed with adventitia at suture line and proximal and distal margins. **B,** Exposed calcification is penetrated with airdrill. **C,** Opening is properly enlarged for anastomosis with laminectomy rongeur. **D,** Anastomotic suturing is performed between polyester graft and mesh-reinforced adventitia.

function and no pseudoaneurysms or dissections were recognized (Fig 3). Although one patient died of coronary heart disease 3 years after surgery, eight patients returned to daily life or full-time work.

DISCUSSION

Rubin et al[8] reported anastomotic technique for small-caliber porcelainized arteries and its significant long-term results, whereas no reports exist regarding anastomosis to procelain aorta. In this method, the distal aorta is chosen as the site of the proximal anastomosis because of its easier accessibility and noninterference with the inferior mesenteric artery perfusion. When the distal aorta occasionally adheres to the inferior vena cava, special precaution should be taken to avoid damage to the distal inferior vena cava. In the graft anastomosis to the porcelain aorta, a side-to-end fashion should be used for technical safety. In patients with bilateral iliac artery occlusion, end-to-end aortic anastomosis for aortobifemoral bypass is technically possible; however, when accidental rupture of the proximal occlusion balloon happens, rush exsanguination from the aortic stump may lead to cardiac arrest. In cases necessitating bifemoral bypass, aortofemoral and femoral graft–femoral crossover bypass through an anterior extraperitoneal route

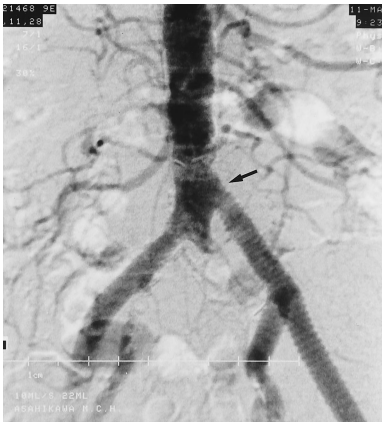

Fig 3. Postoperative arteriogram of aorto–left femoral bypass with present procedure (*arrow,* proximal anastomosis of bypass with polyester graft).

along the pubic margin is recommended as an alternative procedure.

We used polytetrafluoroethylene mesh for the anastomotic reinforcement. Robicsek, Daugherty, and Mullen[9] reported an external grafting procedure for thoracic aortic aneurysms, with acceptable long-term results. In the procedure, aneurysms were dissected free and wrapped with longitudinally opened polyester grafts. However, Dhillon et al[10] reported cases with late aneurysmal rupture after the wrapping operation, stating that the ruptures were probably a consequence of the expansible hemodynamic forces associated with pulsatile flow within the aorta. In terms of the favorable healing properties of the wrapping material, Tanabe et al[11] reported acceptable long-term results regarding mesh wrapping in eight patients with aortic aneurysms and emphasized that mesh materials exhibited excellent compatibility, durability, and healing properties in long-term clinical observation. On the basis of these reports, we used the double layer mesh to increase the effect of reinforcement and to achieve good healing.

Axillofemoral bypass has been performed on patients with high operative risk or with local factors that increase the possibility of anastomotic complications or technical difficulties. Heavily calcified and unclampable aorta is a definitive local factor in determining whether or not to use axillofemoral bypass. However, many active workers are found among patients undergoing dialysis, who commonly have a porcelain aorta but are not necessarily at high risk and would not be satisfied with the results of axillofemoral bypass. This is a reasonable alternative to axillofemoral bypass, although the long-term patency of this technique has not been conclusively proven to be superior to axillofemoral bypass and its use adds the additional concern of possible late formation of anastomotic false aneurysms at the proximal site.

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